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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/096,858	06/12/1998	PRAVIN K. NARWANKAR	AMAT2571.US/	2295

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APPLIED MATERIALS, INC.  
2881 SCOTT BLVD. M/S 2061  
SANTA CLARA, CA 95050

EXAMINER
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MAI, ANH D

ART UNIT	PAPER NUMBER
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2814

DATE MAILED: 05/20/2003

Please find below and/or attached an Office communication concerning this application or proceeding.

<p align="center"><b>Office Action Summary</b></p>	Application No. 09/096,858	Applicant(s) NARWANKAR ET AL.	
	Examiner Anh D. Mai	Art Unit 2814	

**-- Th MAILING DATE of this communication appears on the cover sheet with th correspondence address --**

**Period for Reply**

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

**Status**

- 1) ☒ Responsive to communication(s) filed on 25 February 2003.
- 2a) ☐ This action is **FINAL**.                      2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

**Disposition of Claims**

- 4) ☒ Claim(s) 1-7, 14-29 and 31 is/are pending in the application.
- 4a) Of the above claim(s) \_\_\_\_\_ is/are withdrawn from consideration.
- 5) ☐ Claim(s) \_\_\_\_\_ is/are allowed.
- 6) ☒ Claim(s) 1-7, 14-29 and 31 is/are rejected.
- 7) ☐ Claim(s) \_\_\_\_\_ is/are objected to.
- 8) ☐ Claim(s) \_\_\_\_\_ are subject to restriction and/or election requirement.

**Application Papers**

- 9) ☒ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on \_\_\_\_\_ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.  
       Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
- 11) ☐ The proposed drawing correction filed on \_\_\_\_\_ is: a) ☐ approved b) ☐ disapproved by the Examiner.  
       If approved, corrected drawings are required in reply to this Office action.
- 12) ☐ The oath or declaration is objected to by the Examiner.

**Priority under 35 U.S.C. §§ 119 and 120**

- 13) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).  
       a) ☐ All    b) ☐ Some \* c) ☐ None of:  
           1. ☐ Certified copies of the priority documents have been received.  
           2. ☐ Certified copies of the priority documents have been received in Application No. \_\_\_\_\_.  
           3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).  
       \* See the attached detailed Office action for a list of the certified copies not received.
- 14) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).  
       a) ☐ The translation of the foreign language provisional application has been received.
- 15) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

**Attachment(s)**

- |  |   |
|--|---|
| 1) <input type="checkbox"/> Notice of References Cited (PTO-892)                             | 4) <input type="checkbox"/> Interview Summary (PTO-413) Paper No(s). _____  |
| 2) <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948)         | 5) <input type="checkbox"/> Notice of Informal Patent Application (PTO-152) |
| 3) <input type="checkbox"/> Information Disclosure Statement(s) (PTO-1449) Paper No(s) _____ | 6) <input type="checkbox"/> Other: _____                                    |

## **DETAILED ACTION**

### ***Continued Examination Under 37 CFR 1.114***

1. A request for continued examination under 37 CFR 1.114, including the fee set forth in 37 CFR 1.17(e), was filed in this application after final rejection. Since this application is eligible for continued examination under 37 CFR 1.114, and the fee set forth in 37 CFR 1.17(e) has been timely paid, the finality of the previous Office action has been withdrawn pursuant to 37 CFR 1.114. Applicant's submission filed on February 25, 2003 has been entered.

### ***Amendment***

2. Amendment filed February 25, 2003 has been entered as Paper No. 27. Claims 1-3 and 24 have been amended. Claims 1-7, 14-29 and 31 are pending.

### ***Response to Amendment***

3. The amendment filed February 25, 2003 is objected to under 35 U.S.C. 132 because it introduces new matter into the disclosure. 35 U.S.C. 132 states that no amendment shall introduce new matter into the disclosure of the invention. The added material which is not supported by the original disclosure is as follows: "wherein said dielectric layer is exposed to said electrically neutral reactive oxygen atoms at a second temperature which is less than said first temperature".

Applicant is required to cancel the new matter in the reply to this Office Action.

### ***Claim Rejections - 35 USC § 112***

The following is a quotation of the first paragraph of 35 U.S.C. 112:

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The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same and shall set forth the best mode contemplated by the inventor of carrying out his invention.

4. Claim 2 is rejected under 35 U.S.C. 112, first paragraph, as failing to comply with the written description requirement. The claim(s) contains subject matter which was not described in the specification in such a way as to reasonably convey to one skilled in the relevant art that the inventor(s), at the time the application was filed, had possession of the claimed invention.

There does not appear to be a written description of the claim limitation "wherein said dielectric layer is exposed to said electrically neutral reactive oxygen atoms at a second temperature which is less than said first temperature" in the application as filed.

Although the specification discloses that the transition-metal film is then anneal at a temperature less than 400 °C, however, there is no specific mention that the annealing temperature is less than the forming temperature.

Anneal at 400 °C definitely does not less than 300 °C.

The following is a quotation of the second paragraph of 35 U.S.C. 112:

The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

5. Claims 1-7 and 14-23 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

Claims 1 and 14 recite the limitation "forming an electrode above said active atomic species exposed dielectric layer" in line 10. There is insufficient antecedent basis for this limitation in the claim.

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However, earlier, lines 6-7, the dielectric layer is exposed to “electrically neutral reactive oxygen atoms”.

It appears that the terminology can be used interchangeably and will be treated as such.

### ***Claim Rejections - 35 USC § 103***

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

6. Claims 1, 2, 4-6, 14, 17, 18 and 21-23 are rejected under 35 U.S.C. 103(a) as being unpatentable over DeBoer et al. (U.S. Pub No. 2001/0011740) of record.

With respect to claim 1, as best understood by the examiner, DeBoer teaches a method of forming a dielectric layer of a device substantially similar as claimed including:

forming a dielectric layer (102) on a substrate (101);

generating ionized oxygen atoms in a first chamber;

flowing the ionized oxygen atoms through a conduit coupling the first chamber to a second chamber, wherein the ionized oxygen atoms become electrically neutral reactive oxygen atoms before reaching the second chamber; and

exposing the dielectric layer (102) to the electrically neutral reactive oxygen atoms in the second chamber; and

forming an electrode (106) above the active atomic species exposed dielectric layer. (See Fig. 1A).

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The process of DeBoer comprises exposing the dielectric layer (102) to remote plasma using  $\text{N}_2\text{O}$ ,  $\text{NO}$ ,  $\text{O}_3$  or  $\text{O}_2$ , and the remote plasma is well known to include: generating oxygen ionized atoms in a first chamber (remote plasma chamber); flowing the ionized atoms through a conduit coupling the first chamber to a second chamber (process chamber), wherein the ionized atoms become electrically neutral reactive oxygen atoms before reaching the second chamber. This subject matter has been discussed in the previous Office Action. (Gealy et al. U.S. Patent No. 6,082,375).

With respect to claim 2, as best understood by the examiner, the dielectric is a metal oxide dielectric formed at a first temperature, and wherein the dielectric layer is exposed to the electrically neutral reactive oxygen atoms at a second temperature.

With respect to claim 4, the dielectric layer (102) of DeBoer comprises a metal-oxide.

With respect to claim 5, the dielectric layer (102) of DeBoer comprises transition metal dielectric.

With respect to claim 6, the dielectric layer (102) of DeBoer comprises  $\text{Ta}_2\text{O}_5$ .

With respect to claim 14, as best understood by the examiner, DeBoer teaches a method of annealing a deposited oxide of a device substantially similar as claimed including:

locating a substrate (101) in a first chamber, the substrate (101) having a deposited oxide (102) formed thereon;

generating a plasma comprising ionized oxygen atoms in a second chamber;

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flowing the ionized oxygen atoms from the second chamber into the first chamber through a conduit wherein the ionized oxygen atoms become electrically neutral reactive oxygen atoms while flowing from the second chamber to the first chamber;

exposing the deposited oxide (102) to the reactive oxygen atoms; and

forming an electrode (106) above the active atomic species exposed deposited oxide layer. (See Fig. 1A).

Regarding the generating a plasma in a second chamber, a similar reasoning as that of claim 1 is also applied here.

With respect to claims 17 and 18, the reactive oxygen atoms of DeBoer are formed by generating a plasma from O<sub>2</sub> or N<sub>2</sub>O molecules.

With respect to claim 21, the dielectric layer (102) of DeBoer comprises a metal-oxide.

With respect to claim 22, the dielectric layer (102) of DeBoer comprises transition metal dielectric.

With respect to claim 23, the dielectric layer (102) of DeBoer comprises Ta<sub>2</sub>O<sub>5</sub>.

7. Claim 3 is rejected under 35 U.S.C. 103(a) as being unpatentable over DeBoer '740 as applied to claim 1 above, and further in view Sun et al (U.S. Patent No. 5,841,186) of record.

DeBoer teaches exposing the dielectric layer to electrically neutral reactive oxygen atoms in the second chamber.

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Thus, DeBoer is shown to teach all the features of the claim with the exception of forming the dielectric layer comprises titanium oxide.

However, Sun teaches capacitor dielectric layer comprises titanium oxide or tantalum penta oxide and the benefit of annealing dielectric layer following the deposition.

Therefore, it would have been obvious to one having ordinary skill in the art at the time of invention to form the dielectric layer (102) of DeBoer comprises titanium oxide as taught by Sun because titanium oxide provide higher dielectric capacitance for the capacitor.

8. Claim 20 is rejected under 35 U.S.C. 103(a) as being unpatentable over DeBoer '740 as applied to claim 14 above, and further in view Toshio (JP 04-092423) of record.

DeBoer teaches all of the features of the claim with the exception of forming the deposited oxide including silicon-oxide.

However, Toshio teaches forming a deposited oxide on a substrate comprising silicon-oxide.

Therefore, it would have been obvious to one having ordinary skill in the art at the time of the invention was made to form the deposited oxide of DeBoer comprising silicon-oxide as taught by Toshio since silicon-oxide is also benefited from the ionized oxygen plasma treatment to enhance water-resistant property. Moreover, silicon oxide is a well known capacitor dielectric.

9. Claims 16 and 19 are rejected under 35 U.S.C. 103(a) as being unpatentable over DeBoer '740 as applied to claim 14 above, and further in view of Slomowitz (U.S. Patent No. 4,88,088), of record.



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With respect to claim 16, DeBoer teaches all the features of the claim with the exception of explicitly disclosing that the remote plasma generator (second chamber) is of a microwave applicator cavity.

However, Slomowitz teaches a remote plasma generator comprises a microwave applicator cavity to sustain the reactive atoms (plasma).

Therefore, it would have been obvious to one having ordinary skill in the art at the time of invention to generate the plasma of DeBoer using a microwave applicator cavity generator as taught by Slomowitz to sustain excited reactive atoms during transport to the processing chamber.

With respect to claim 19, the reactive oxygen atoms of DeBoer are formed by generating a plasma from O<sub>2</sub>, remotely.

10. Claims 24, 25, 27 and 28 are rejected under 35 U.S.C. 103(a) as being unpatentable over DeBoer '740 in view of Slomowitz '088.

With respect to claim 24, DeBoer teaches a method of forming capacitor substantially similar as claimed including:

forming a bottom electrode (104);

depositing a transition metal dielectric (102) on the bottom electrode (104) in a deposition chamber;

generating a plasma comprising ionized oxygen atoms by forming the plasma from an oxygen (O<sub>2</sub>) gas in a remote plasma generator chamber;

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flowing the ionized oxygen atoms through a conduit coupling the remote plasma generator chamber and the deposition chamber, wherein the ionized atoms become electrically neutral reactive oxygen atoms before reaching the second chamber;

annealing the transition metal dielectric (102) in the deposition chamber by exposing the transition metal dielectric to the electrically neutral reactive oxygen atoms; and

forming a top electrode (106) above the reactive atomic species exposed transition metal dielectric (102). (See Fig. 1A).

Thus, DeBoer is shown to teach all the features of the claim with the exception of explicitly disclosing that the remote plasma generator is of a microwave applicator cavity.

However, Slomowitz teaches a type of remote plasma generator comprises a microwave applicator cavity to sustain ionized reactive atoms (plasma).

Therefore, it would have been obvious to one having ordinary skill in the art at the time of invention to generate the plasma of DeBoer using a microwave applicator cavity generator as taught by Slomowitz to sustain the excited reactive atoms during transport to the annealing chamber.

Regarding the characteristic of the plasma generated remotely, the same reasoning as that of claim 1 is also applied here.

With respect to claims 25 and 27, the transition metal dielectric (102) of DeBoer is Ta<sub>2</sub>O<sub>5</sub> deposited by CVD utilizing a source gas as claimed.

With respect to claim 28, the transition metal dielectric (102) of DeBoer is deposited at a temperature within the claimed range.

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11. Claims 26 and 29 are rejected under 35 U.S.C. 103(a) as being unpatentable over DeBoer '740 and Slomowitz '088 as applied to claim 24 above, and further in view of Hasegawa (U.S. Patent No. 5,677,015).

DeBoer and Slomowitz teach all of the features of the claim with the exception of forming the transition metal dielectric ( $Ta_2O_5$ ) utilizing TAT-DMAE and  $N_2O$  as the source gas.

However, Hasegawa teaches forming the transition metal dielectric (22) utilizing source gases comprising TAT-DMAE and  $N_2O$ .

Therefore, it would have been obvious to one having ordinary skill in the art at the time of the invention was made to form the transition metal dielectric ( $Ta_2O_5$ ) of DeBoer utilizing the source gases as taught by Hasegawa since forming  $Ta_2O_5$  utilizing these gases are well known.

12. Claims 7 and 15 are rejected under 35 U.S.C. 103(a) as being unpatentable over DeBoer '740 as applied to claims 1 and 14 above, and further in view of Park et al. (U.S. Patent No. 5,910,218) of record.

DeBoer teaches all the features of the claim with the exception of explicitly disclosing the temperature of the substrate during the plasma anneal.

However, Park teaches the temperature during a plasma annealing (250 to 350 °C) is lower than that of film depositing to prevent recombination of the excited reactive atoms.

Therefore, it would have been obvious to one having ordinary skill in the art at the time of invention to anneal the deposited oxide of DeBoer in reactive oxygen atoms at the temperature as taught by Park to prevent the excited reactive atoms from recombination thus, less effective.

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13. Claim 31 is rejected under 35 U.S.C. 103(a) as being unpatentable over DeBoer '740 and Slomowitz '088 as applied to claim 24 above, and further in view of Park et al. (U.S. Patent No. 5,910,218) of record.

DeBoer teaches all the features of the claim with the exception of explicitly disclosing the temperature of the substrate during the plasma anneal.

However, Park teaches the temperature during a plasma annealing (250 to 350 °C) is lower than that of film depositing to prevent recombination of the excited reactive atoms.

Therefore, it would have been obvious to one having ordinary skill in the art at the time of invention to anneal the deposited oxide of DeBoer in reactive oxygen atoms at the temperature as taught by Park to prevent the excited reactive atoms from recombination thus, less effective.

#### ***Response to Arguments***

14. Applicant's arguments filed February 25, 2003 have been fully considered but they are not persuasive.

Applicant argues: Applicant does not understand DeBoer or any of the cited references to teach annealing a dielectric film with highly energized electrically neutral reactive oxygen atoms in order to improve the electrical characteristics of a dielectric film of a semiconductor device.

In response to applicant's argument that the references fail to show certain features of applicant's invention, it is noted that the features upon which applicant relies (i.e., exposing the dielectric layer to reactive oxygen atom in order to improve the electrical characteristics of a dielectric film of a semiconductor device) are not recited in the rejected claim(s). Although the

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claims are interpreted in light of the specification, limitations from the specification are not read into the claims. See *In re Van Geuns*, 988 F.2d 1181, 26 USPQ2d 1057 (Fed. Cir. 1993).

However, the process of DeBoer clearly includes exposing the dielectric layer to such a reactive oxygen atoms using remote plasma as claimed thus, the treatment should inherently result in improving the electric characteristic of the dielectric layer as well.

Applicant asserts that DeBoer fails to teach annealing a dielectric film with highly reactive electrically neutral oxygen atoms as claimed.

However, as discussed in the previous Office Action, the “highly reactive electrically neutral oxygen atoms” is the product of oxygen containing gas exiting the remote plasma chamber of DeBoer. This matter is well known. (See Gealy ‘375 and Slomowitz ‘088).

DeBoer clearly teaches exposing the dielectric layer to active atomic species comprising oxygen generated from a remote plasma. (See [0037]). Therefore, DeBoer alone or in combination with others references, clearly render the claims obvious.

With respect to the Declaration, Applicant concludes that Applicant is unable to find a single claim of DeBoer (claims 1-54) which claim the same as the present invention.

However, claim 29 of DeBoer recites: forming a tantalum oxide film (dielectric layer as claimed); annealing the tantalum oxide film in an environment containing **oxygen**; wherein the step of annealing comprises the step of annealing in nitrogen atmosphere and a plasma that is one of a group consisting of ...**remote plasma**....

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Note that, as discussed above, the "electrically neutral reactive oxygen atoms" is the plasma product exiting the remote plasma chamber.

Since DeBoer claimed the same invention as that of the presently claimed, therefore, the Declaration is **ineffective**.

### *Conclusion*

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Anh D. Mai whose telephone number is (703) 305-0575. The examiner can normally be reached on 8:30AM-5:00PM.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Wael Fahmy can be reached on (703) 308-4918. The fax phone numbers for the organization where this application or proceeding is assigned are (703) 308-7722 for regular communications and (703) 308-7722 for After Final communications.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is (703) 308-0956.

A.M  
May 8, 2003

  
LONG PHAM  
PRIMARY EXAMINER